Western Trauma Association Critical Decisions in Trauma: Management of pelvic fracture with hemodynamic instability—2016 updates

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Since the publication of the 2008 Western Trauma Association algorithm for the management of pelvic fracture with hemodynamic instability,[1] the approach in general has not changed, but several components of the approach have come into sharper focus, and a new component is gaining some traction in a few centers (Fig. 1). This manuscript is an interim update to recognize some of the changes. The accompanying graphic is marked where it differs from the 2008 algorithm, and explanatory text follows.

Pelvic ring injuries range from low-energy pubic ramus fractures to high-energy unstable patterns that can result in hemodynamic instability. The Young and Burgess system identified injury patterns correlating with the direction of the applied force. This classification system described four pelvic injury patterns: anterior posterior compression (APC), lateral compression (LC), vertical shear (VS), and combined injuries. LC and APC injuries are further classified into progressively numbered stages from I to III, which represent increasing displacement and severity of injury.[2] The internal iliac vasculature and the presacral venous plexus are located just anterior to the ligaments that bind the iliac bones to the sacrum. Disruption of these sacral-iliac ligamentous complexes can cause significant pelvic hemorrhage.[3] Potential lethal injury patterns include those with iliac wing fractures and transforaminal sacral fractures.[4]

A. The years since 2008 have seen an explosion in the use of physiologically guided massive transfusion protocols, with viscoelastic coagulation testing [thromboelastography (TEG) and thromboelastometry (ROTEM)] guidance tailoring defined ratio protocols to physiologic endpoints.[5–9] Nearly a quarter of trauma patients present with acute coagulopathy, which is associated with a 4-fold increase in mortality.[10] Trauma-induced coagulopathy (TIC) is a hypocoagulable state that occurs within the first 24 hours of injury as a response to a variety of interlinked causes such as tissue hypoperfusion, inflammation, and activation of the neurohumoral system. Acidosis, hemodilution, and hypothermia during resuscitation further exacerbate the ongoing coagulopathy.[11] Recent studies suggest tissue hypoperfusion leading to protein C activation may play an important role in TIC. Other proposed mechanisms include hyperfibrinolysis, clotting factor dysfunction, and endothelial glycocalyx degradation.[12–14] Early recognition of TIC by viscoelastic testing including TEG and ROTEM may potentially be used to guide blood-product transfusion and reduce mortality. A randomized controlled trial has recently been published showing that viscoelastic assay guided resuscitation of trauma patients requiring use of a massive transfusion protocol had a lower mortality than a group resuscitated based on conventional coagulation assays.[15]

B. Noninvasive external pelvic stabilization with commercially available wrapping devices or improvisation with bed sheets has become standard and can be applied in the prehospital arena. Commercially available devices offer a standardized approach, with clear instructions for application, and have convenient fasteners for maintaining closure. Alternatively, pelvic sheeting is applied at the level of the greater trochanters and secured with large Kelly clamps to avoid pressure from knots.[16] Circumferential pelvic sheeting and binders are contraindicated in lateral compression fractures because of the applied concentric force, which can worsen the deformity. A cadaveric study in 2013 comparing the efficacy of circumferential pelvic sheeting versus a commercial pelvic binder (T-POD; Pyng Medical Corp., Richmond, British Columbia, Canada) for stabilization of pelvic fractures demonstrated no significant differences during motion-generated

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This algorithm was presented at the 45th annual meeting of the Western Trauma Association, March 1–6, 2015, in Telluride, Colorado.

The Western Trauma Association (WTA) develops algorithms to provide guidance and recommendations for particular areas but does not establish the standard of care. The WTA algorithms are based on the evidence available in the literature and the expert opinion of the task force in the recent time frame of the publication. The WTA considers use of the algorithm to be voluntary. The ultimate determination regarding its application is to be made by the treating physician and health care professionals with full consideration of the individual patient's clinical status and available institutional resources. Moreover, it is not intended to take the place of judgments of health care providers in diagnosing and treating particular patients.

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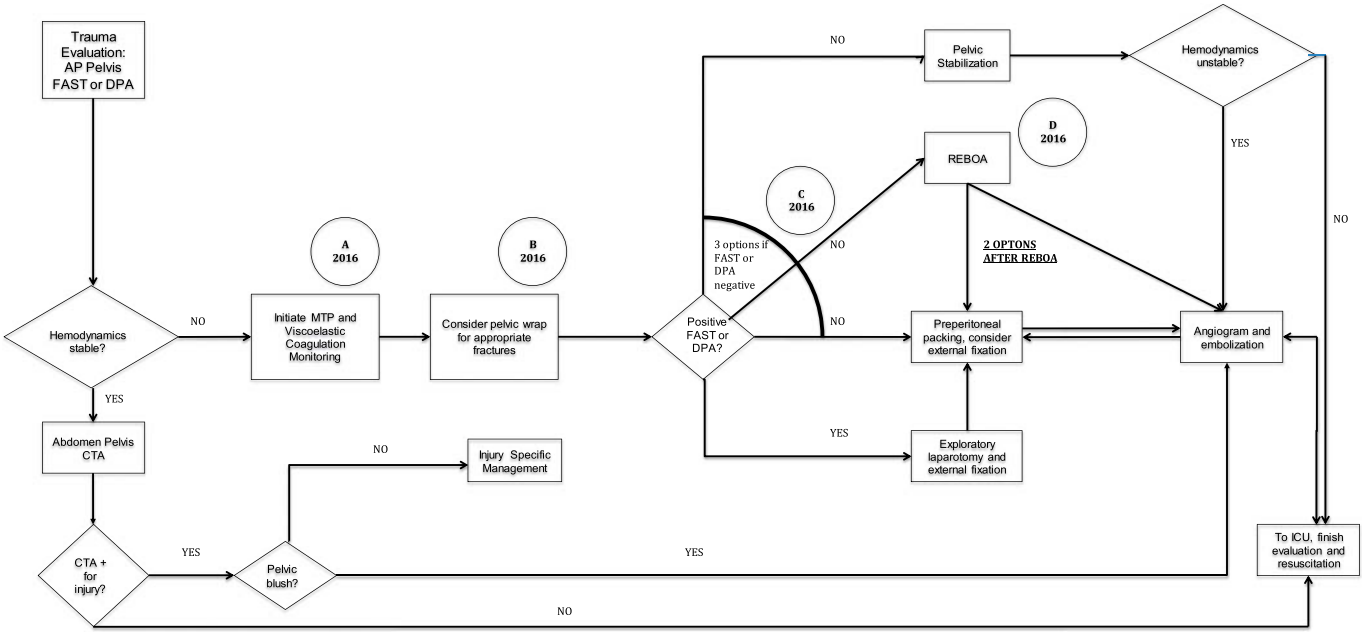

Figure 1. Management of pelvic fracture with hemodynamic instability.

activities.[17] No differences in outcomes have been demonstrated between pelvic sheeting and commercial devices.

C. After a negative FAST or DPA in appropriate patients, there are three complementary, and not mutually exclusive, options that can be performed immediately: pelvic stabilization, preperitoneal packing, or REBOA. Angiographic embolization remains a mainstay either as the initial phase of stabilization or as a follow-up to preperitoneal packing.[18–20] Angiography targets bleeding from an arterial source, whereas preperitoneal packing controls bleeding from venous and bony sources (85% of patients). Patients who do not respond to fluid resuscitation and prompt implementation of mechanical stabilization should be considered candidates for angioembolization. Many authors recommend early angiography and embolization to improve patient outcome. However, angiography is a lengthy procedure precluding other simultaneous therapeutic interventions. In addition, there can be considerable delay getting to the angiography suite, which may not be tolerated in hemodynamically unstable patients. The most appropriate timing of angiography remains an ongoing debate. The development of a hybrid trauma operating room is an emerging trend to avoid delay in hemorrhage control from unnecessary patient movements. This hybrid OR model offers resuscitation with angiographic and operative capabilities.

Temporary fracture stabilization can be achieved by application of a percutaneous external fixator. Anterior external fixation performed through the iliac wings or supra-acetabular region is indicated in open book fractures with intact posterior ligaments. In posterior pelvic ring disruption, the pelvic C-clamp is applied to the dorsal iliac bones. The frame design and pin location are selected on the basis of pelvic injury pattern, patient body habitus, available imaging, and surgeon experience.[3,16,21] The application of orthopedic hardware in the setting of hemodynamic instability has fallen out of favor because of the technical demands and time-consuming nature of the procedure in the emergency setting.[22–24]

In contrast to early percutaneous external pelvic fixation, preperitoneal pelvic packing has become increasingly popular as it is easy to perform, no specialty consultants are needed, and the feedback on the success or failure of the procedure is immediate. It also allows the general surgeon to go to the place where he or she is most comfortable with the unstable patient, the operating room.[25–31] In a study of 40 hemodynamically unstable patients with pelvic fractures, direct retroperitoneal pelvic packing was as effective as angiography in stabilizing pelvic bleeding.[27] Preperitoneal packing is performed by making an 8-cm midline incision starting above the pubis extending toward the umbilicus. Skin, subcutaneous tissue, and fascia are opened in the midline. Care is taken to avoid entry into the peritoneal cavity. The bladder is retracted laterally and three laparotomy pads are placed sequentially deep to the pelvic brim toward the iliac vessels on each side, with the sacrum defining the posterior limit of the packing. The fascia and skin are then closed. Removal or exchange of the packs should take place in 24 to 48 hours. In experienced hands, the procedure can be performed in 20 minutes.[1] Packing should be followed by application or reapplication of a binder, or external fixation, depending on local resources and clinical condition.

D. Resuscitative endovascular balloon occlusion of the aorta (REBOA) is a surgeon-performed endovascular approach to aortic inflow occlusion to the pelvis. The aim of REBOA is to temporarily control arterial hemorrhage and preserve cerebral and myocardial perfusion. REBOA deployed in Aortic Zone 3 (just above the aortic bifurcation) has the potential to provide immediate hemorrhage control in hemodynamically unstable patients with pelvic fractures. Although REBOA effectively increases systolic blood pressure in the setting of hemorrhagic shock, there is no clear evidence suggestive of a reduction in mortality.[32] The role of REBOA in this algorithm remains uncertain and the optimal method to train practitioners to perform this procedure in a timely fashion has not yet been defined. Experience with this new technique is limited, but growing. In a

research setting, trained acute care surgeons are able to perform this procedure in 6 minutes. With proper preparation and availability of local resources, REBOA can be an effective adjunct in the management of hemorrhagic shock, prolonging survival until definitive hemostasis can be obtained through preperitoneal packing or angiographic embolization.[33–37]

In summary, emerging state-of-the-art management of the hemodynamically unstable patient with a pelvic fracture in 2016 includes hemostatic resuscitation guided by viscoelastic testing, external pelvic stabilization with wrapping devices, and definitive hemorrhage control with angiographic embolization and/or preperitoneal packing. During resuscitation, TIC can be recognized early by the use of viscoelastic assay such as TEG and ROTEM to guide blood-product transfusion. Noninvasive external pelvic stabilization with pelvic sheeting or commercially available devices can be applied in the prehospital setting to provide temporary stabilization and reduce hemorrhage from bony surfaces and venous disruption. Early angiography and embolization along with preperitoneal packing are complementary techniques in definitive hemorrhage management. Although promising, the role of REBOA as an adjunct in the management of hemorrhagic shock secondary to pelvic fractures remains uncertain. Temporization with REBOA is a promising new frontier whose exact role is yet to be determined.

DISCLOSURE

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